The HARP family of hyper-angular imaging polarimeters and its applications from aircraft and space

J. Vanderlei Martins[a,b,c,*], Brent McBride[a,b,c], Anin Puthukkudy[a,b,c], Xiaoguang (Richard) Xu[b,c], Noah Sienkiewicz[a,b,c], Henrique M. J. Barbosa[a,c,d], Roberto Fernandez-Borda[a,b,c], Lorraine Remer[b,c], Oleg Dubovik[e], and Pavel Litvinov[f]

[a]*Department of Physics, University of Maryland Baltimore County, Maryland, USA*
[b]*Joint Center for Earth Systems Technology, Maryland, USA*
[c]*Earth and Space Institute, UMBC, Maryland, USA*
[d]*Instituto de Física, Universidade de São Paulo, São Paulo, Brasil*
[e]*dLaboratoire d'Optique Atmosphérique, CNRS/Université Lille, Villeneuve d'Ascq, France*
[f]*GRASP-SAS, Villeneuve d'Ascq, France*

[*]*Presenting author (martins@umbc.edu)*

The Hyper-Angular Rainbow Polarimeter (HARP) provides an innovative approach for the measurement of cloud, aerosol and surface properties by utilizing a highly accurate and simultaneous measurement of the *I*, *Q*, and *U* parameters of the Stokes vectors. HARP measurements are performed in a wide field in both cross track (94°) and along track (114°) directions, allowing for multiple viewing angles (up to 60 directions) of each ground pixel. HARP's spectral coverage has been studied from UV to Shortwave Infrared Wavelengths but so far has been implemented between 440 to 870 nm. Two practical implementations of the HARP system have been implemented (AirHARP and HARP CubeSat) and a third version is currently under construction (HARP2) for the PACE satellite mission.

The AirHARP sensor has flown in two NASA aircraft missions: the Lake Michigan Ozone Study (LMOS) aboard the NASA UC12 aircraft, and the Aerosol Characterization from Polarimeter and Lidar (ACEPOL) aboard the NASA ER2 aircraft. In particular, during ACEPOL, AirHARP has flown with three other imaging polarimeters (RSP, SPEX, and AirMSPI) and a Lidar system (HSRL2). The performance of the AirHARP instrument during these campaigns and its application on the retrieval of cloud and aerosol microphysical parameters will be presented here. On the cloud side, HARP's hyperangular capability allows for a pixel level retrieval of the water cloud doplet distribution emphasizing the high resolution mapping of the cloud effective radius and effective variance distributions. On the aerosol side, retrievals have been performed with the GRASP algorithm over background and heavy smoke conditions over multiple surface types.

The HARP CubeSat system builds upon the AirHARP experience and is currently planned to launch to space by the Fall of 2019 as a technology demonstration of this measurement concept from space. As such, due to inherent limitations of the CubeSat platform (size, power, data rate, etc.), HARP CubeSat will collect a very limited data set from space corresponding to targeted/selected regions on the ground. On the other hand, the HARP2 system to be launched on the PACE satellite in 2023 is planned to produce global coverage in 2 days. Furthermore, HARP2 has improved accuracy due to improved signal to noise ratios, and enhanced calibration schemes onboard the spacecraft, which will be discussed in this presentation.

Mode of presentation: Invited